Defense Nuclear Agency
Alexandria, VA 22310-3398

DNA-TR-92-173

Compliance Monitoring for the Chemical Weapons Convention
Preliminary Operational Concepts—An Adversarial Analysis

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July 1993

Technical Report

CONTRACT No. DNA 001-91-C-0030

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	930701	Technical 910905 – 911112

4. TITLE AND SUBTITLE

Compliance Monitoring for the Chemical Weapons Convention Preliminary Operational Concepts—An Adversarial Analysis

5. FUNDING NUMBERS

C - DNA 001-91-C-0030
PE - 62715H
PR - TA
TA - TA
WU - DH416133

6. AUTHOR(S)

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8. PERFORMING ORGANIZATION REPORT NUMBER

2734

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Defense Nuclear Agency
6801 Telegraph Road
Alexandria, VA 22310-3398
OPAC/Steinberger

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

DNA-TR-92-173

11. SUPPLEMENTARY NOTES

This work was sponsored by the Defense Nuclear Agency under RDT&E RMC Code B4613D TA TA 00045 OPAC 2600A 25904D.

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The objective of this report is to assess preliminary operational concepts developed by the U.S. Army Chemical Research, Development and Engineering Center (CRDEC). The "Adversarial Analysis Methodology for the Chemical Weapons Convention," developed by the JAYCOR Team, provides a conceptual framework and criteria for this assessment. Adversarial analysis (AA) complements the CRDEC methodology by accounting for noncompliance activities and includes risk and vulnerability analyses as well as a politico-strategic assessment of potentially noncompliant nations.

CRDEC highlights many difficulties, flaws, and discrepancies in the formal CWC verification regime. AA helps overcome these shortcomings. First, it identifies how an adversary might accomplish cheating, spoofing, and circumvention (CSC), including underlying motivations and objectives. Second, it highlights potential verification system vulnerabilities that would permit CSC. Finally, it assesses the impact of such activities qualitatively and quantitatively. The end product of this approach is a vulnerability assessment report describing the potential effectiveness of various deceptive practices and recommendations for improving the verification regime's resistance to deception.

14. SUBJECT TERMS

On-Site Inspections	CRDEC	
Adversarial Analysis	Verification	Deception
Chemical Weapons Convention	Chemical Weapons	Noncompliance

15. NUMBER OF PAGES

22

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAR

NSN 7540-280-5500

Standard Form 298 (Rev.2-89)
Prescribed by ANSI Sts. 239-18
298-102

CLASSIFIED BY:

N/A since Unclassified.

DECLASSIFY ON:

N/A since Unclassified.

7. Performing Organization Name (s) and Address (es)

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EXECUTIVE SUMMARY

The objective of this report is to assess from an adversarial perspective the preliminary operational concepts described in the "Compliance Monitoring for the Chemical Weapons Convention" report by the U.S. Army Chemical Research, Development and Engineering Center (CRDEC). The "Adversarial Analysis Methodology for the Chemical Weapons Convention," developed by the JAYCOR Team, provides the conceptual framework and criteria for this assessment.

CRDEC has been tasked by DNA to develop preliminary operational concepts for verification inspections. To accomplish this task, CRDEC needs to: assess sensor, sampling, and protective equipment; test sampling methodology and chain-of-custody controls, and; conduct field demonstrations of available technology. The systematic approach used by CRDEC, based on a strict interpretation of the Chemical Weapons Convention (CWC) draft verification provisions, is largely insufficient for dealing with calculated noncompliance activities. Adversarial analysis (AA) complements the CRDEC methodology by accounting for the full spectrum of noncompliant activities, including risk and vulnerability analyses as well as a politico-strategic assessment of potentially noncompliant nations.

CRDEC highlights many difficulties, flaws, and discrepancies in the formal CWC verification regime. AA can significantly enhance this effort. First, it can identify how an adversary nation might accomplish potential cheating, spoofing, and circumvention (CSC), including the underlying motivations and objectives. Second, it can reveal potential verification system vulnerabilities that would permit CSC. Finally, it can assess the impact of such activities, both qualitatively and quantitatively. The end product of this approach is a vulnerability assessment report describing the potential effectiveness of various deceptive practices and recommendations for improving the resistance of the verification regime to deception. Noncompliance activities by host parties need to be factored into any credible verification regime and supported by effective verification technologies. Because of the scope of potential CSC, greater attention should be paid to noncompliance scenarios which reflect a plausible blueprint of what an adversary could do to cheat, and what it must conceal in order to avoid detection by the verification regime. The CRDEC methodology and scenarios identify the following CSC practices, among others:

- Store CW agents and production facilities at clandestine locations.
- Rigorously implement verification procedures to inhibit access by the inspection team.
- Exploit pre-inspection formalities to mislead or delay inspectors.
- Manipulate amount of data released -- too little or too much data.
- Cover a chemical agent production facility by embedding it within a commercial chemical facility.
- Cover CW violations with dilution, designer decontamination, and masking.
- Neutralize security and monitoring systems by fabricating safety "emergencies."
- Tamper with vulnerable process monitoring equipment.
- Exploit the interval between CWC entry into force and cessation of all CW production for a rapid batch production.
- Exceed annual production ceilings in allowed facilities.

CONVERSION TABLE

Conversion factors for U.S. customary to metric (SI) units of measurement

To Convert From	To	Multiply
angstrom	meters (m)	1.000 000 X E-10
atmosphere (normal)	kilo pascal (kPa)	1.013 25 X E+2
bar	kilo pascal (kPa)	1.000 000 X E+2
barn	meter^2 (m^2)	1.000 000 X E-28
British Thermal unit (thermochemical)	joule (J)	1.054 350 X E+3
calorie (thermochemical)	joule (J)	4.184 000
cal (thermochemical)/cm^2	mega joule/m^2(MJ/m^2)	4.184 000 X E-2
curie	giga becquerel (GBq)*	3.700 000 X E+1
degree (angle)	radian (rad)	1.745 329 X E-2
degree Fahrenheit	degree kelvin (K)	$t_K = (t^\circ f + 459.67)/1.8$
electron volt	joule (J)	1.602 19 X E-19
erg	joule (J)	1.000 000 X E-7
erg/second	watt (W)	1.000 000 X E-7
foot	meter (m)	3.048 000 X E-1
foot-pound-force	joule (J)	1.355 818
gallon (U.S. liquid)	meter^3 (m^3)	3.785 412 X E-3
inch	meter (m)	2.540 000 X E-2
jerk	joule (J)	1.000 000 X E+9
joule/kilogram (J/Kg) (radiation dose absorbed)	Gray (Gy)	1.000 000
kilotons	terajoules	4.183
kip (1000 lbf)	newton (N)	4.448 222 X E+3
kip/inch^2 (ksi)	kilo pascal (kPa)	6.894 757 X E+3
ktap	newton-second/m^2 (N-s/m^2)	1.000 000 X E+2
micron	meter (m)	1.000 000 X E-6
mil	meter (m)	2.540 000 X E-5
mile (international)	meter (m)	1.609 344 X E+3
ounce	kilogram (kg)	2.834 952 X E-2
pound-force (lbf avoirdupois)	newton (N)	4.448 222
pound-force inch	newton-meter (N·m)	1.129 848 X E-1
pound-force/inch	newton/meter (N/m)	1.751 268 X E+2
pound-force/foot^2	kilo pascal (kPa)	4.788 026 X E-2
pound-force/inch^2 (psi)	kilo pascal (kPa)	6.894 757
pound-mass (lbm avoirdupois)	kilogram (kg)	4.535 924 X E-1
pound-mass-foot^2 (moment of inertia)	kilogram-meter^2 (kg·m^2)	4.214 011 X E-2
pound-mass/foot^3	kilogram/meter^3 (kg/m^3)	1.601 846 X E+1
rad (radiation dose absorbed)	Gray (Gy)**	1.000 000 X E-2
roentgen	coulomb/kilogram (C/kg)	2.579 760 X E-4
shake	second (s)	1.000 000 X E-8
slug	kilogram (kg)	1.459 390 X E+1
torr (mm Hg. 0°C)	kilo pascal (kPa)	1.333 22 X E-1

*The becquerel (Bq) is the SI unit of radioactivity: Bp = 1 event/s.

**The Gray (Gy) is the SI unit of absorbed radiation.

TABLE OF CONTENTS

Section		Page
	EXECUTIVE SUMMARY	iii
	CONVERSION TABLE	iv
1	THE CRDEC APPROACH	1
	1.1 Operational Concepts and Excursions	1
	1.2 Inspection Functions	3
	1.3 Measures of Effectiveness	4
2	THE JAYCOR APPROACH	5
	2.1 Noncompliant Behavior	6
	2.2 Host Country Role	6
	2.3 Intrusiveness and Confidentiality	7
	2.4 Inspection of Declared Stockpiles (Scenarios 1 – 2)	8
	2.5 Destruction and Closure Provisions (Scenarios 3 – 5)	10
	2.6 Permitted Production (Scenarios 6 – 8)	10
	2.7 Challenge Inspections (CRDEC Scenarios 9 – 10)	11
3	CONCLUSION	13

SECTION 1
THE CRDEC APPROACH

Verifying compliance with the forthcoming Chemical Weapons Convention (CWC) will constitute a major challenge to the United States and other state parties committed to a ban on chemical weapons (CW). Most of the signatory nations will abide by the provisions of the agreement and will declare and destroy their stocks. However, the scope of cheating, spoofing, and circumvention (CSC) of the treaty potentially will be extensive as more nations attain, or strive to attain, CW capabilities. Thus, there is reason for careful analysis and preparation of the CWC verification and compliance regimes.

The objective of this paper is to assess from the perspective of an adversary to the CWC the preliminary operational concepts described in the "Compliance Monitoring for the Chemical Weapons Convention" report (CRDEC-CR-098) and to apply the criteria developed by the JAYCOR Team in "Adversarial Analysis Methodology for the Chemical Weapons Convention."

1.1 OPERATIONAL CONCEPTS AND EXCURSIONS.

DNA funds the U.S. Army Chemical Research, Development and Engineering Center (CRDEC) to oversee:

1) assessment of sensor, sampling, and protective equipment;

2) sampling methodology and chain-of-custody controls; and

3) field demonstrations of available technologies.

In outlining its methodology, CRDEC introduces a number of operational concepts "defined as the 'how' used by an inspection team to accomplish the aims of verification inspections." (CRDEC, Sec. 1.3, p. 10) The CWC verification requirements are broken down into ten discrete scenarios according to functional areas. Operational concepts establish specific objectives for each verification scenario. The CWC "Rolling Text" (CD/1173) serves as the basis for the baseline operational concepts. The treaty outlines general protocols on the rights and duties of the inspection team and the inspected state party as well as the administrative arrangements and pre- and post-inspection activities that apply to all verification scenarios (see pp. 25-29, Sec 4.1–4.4). More (+) and less (-) thorough inspection concepts, or excursions, were developed regardless of whether they were required or allowed by the rolling text. The excursions vary in cost, intrusiveness, and effectiveness. Through this process, CRDEC seeks to select the optimal verification strategy for each scenario, based on the cost, effectiveness, and intrusiveness of the various excursions.

Operational concepts are comprised of inspection functions (identify, quantify, secure, or confirm) and their corresponding inspection methods. The functions establish the requirements needed to achieve the verification aim. The hierarchical structure of an operational concept is shown in Table 1.1.

Table 1.1. Hierarchical structure of operational concept and definition of terms.

1) **Operational Concept**	Based on Verification Scenario, Aims, and CWC Provisions
2) **Function**	System Level Requirement to Achieve Aims such as "Identify" and "Quantify" to "Confirm Stockpile Declaration"
3) **Method**	Technical Approach to Perform a Function such as "On-Site Chemical Analysis" to "Identify"
4) **Steps**	Series of Actions to Implement a Method such as – Penetrate Munition to Access Agent – Withdraw Agent Sample – Deliver Sample for Analysis – Identify Chemical for "On-Site Chemical Analysis"
5) **Equipment/Personnel Procedures**	Requirement to Accomplish Step such as Analytic Chemist Using a Gas-Chromatograph and Appropriate Procedures to Analyze for Schedule 1 Agents

The various verification systems, or excursions, are tested initially for each verification scenario. CRDEC measures each system by three criteria: effectiveness, intrusiveness, and cost. The most relevant criterion in judging each verification system is effectiveness. Effectiveness, moreover, is a desired goal, whereas cost and intrusiveness are only measures. In an earlier work, CRDEC noted that the goal of making cheating difficult is, to some extent, a cost issue.[1] However, the importance of intrusiveness and cost vary with their contribution to effectiveness. Increased cost is a direct result of increased redundancy and increased levels of technology. Cost also increases with the level and duration of intrusiveness, including the use of continuous monitoring, rather than systematic inspections, for some scenarios. When various excursions achieve the same level of effectiveness, those with the lowest level of intrusiveness and cost are desired.

However, CRDEC uses a systematic approach based on the framework of the CWC "Rolling Text" that is largely insufficient for dealing with calculated noncompliance activities, especially where a state party intentionally fails to declare a CW production or storage site. The CRDEC methodology takes a legalistic and functional approach to questions of CWC compliance. The objective of this analysis is to apply the CRDEC conceptualization of inspection exercises to a series of verification scenarios in which CSC activities might occur. This undertaking highlights many of the difficulties, flaws, and discrepancies of a formal CWC verification regime. CRDEC recognizes that a subsequent requirement will involve "a risk analysis which considers additional factors such as political factors and cost." (Sec. 1.3, p. 13) Adversarial analysis (AA) complements the CRDEC approach by taking into account the full spectrum of noncompliant activities, including risk and vulnerability analyses as well as a politico-strategic assessment of potentially noncompliant nations.

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[1] See p.18, "Compliance Monitoring for the Chemical Weapons Convention: Report on the Chemical Weapons Treaty Verification Workshop," Sponsored by CRDEC under DNA Project # TA, Task # TC, and Work Unit # 00001.

1.2 INSPECTION FUNCTIONS.

The aims of each verification scenario dictate the operational concepts. The concepts are linked to specific sensors and detection technologies by specific requirements, or inspection functions, within each scenario. There are four basic functions:

- *identify* the types of chemicals and equipment at a facility;
- *quantify* the number, weight, and size of chemicals, stockpiles, and equipment;
- *secure* a facility or area to prevent the undetected removal of CW stocks or illegal production of CW materials; and
- *confirm* that the destruction of CW stocks or facilities is witnessed and takes place according to schedule.

Individual inspection functions establish the means for achieving part of the overall verification goal; collectively they provide the framework for designing verification inspections. The functions can be implemented in sequence, simultaneously, or a combination of the two. The following examples illustrate alternative sequences:

- In verifying declared CW stocks (Scenario 1), the perimeter and storage bunkers are *secured* prior to the inspection; during the inspection items are *identified* and *quantified* simultaneously; following the inspection the site is *secured* until the items are removed for destruction.

- In verifying the declaration, closure, and destruction of a CW production facility (Scenarios 4 and 5), key equipment and facilities are *identified* initially; the facility then is *secured* to assure the non-production of chemical agent; finally, inspectors *confirm* that key production equipment and facilities are destroyed according to plan.

The role of the inspection functions within the operational concepts provides an instrumental framework for applying AA to the planning of verification systems. The two-fold purpose of verification is to confirm the accuracy of declared CW activities, and conversely to confirm that prohibited activities are not occurring contrary to the declarations. Despite providing specific guidance for achieving these aims, verification inspections are not specifically aimed at detecting noncompliance. By analyzing the entire verification system, including the setting and activities that fall outside the scope of the system, AA highlights gaps between the objectives of the adversary and the objectives of the verification system. The failure to detect noncompliance may stem from technological failures or vulnerabilities. However, the failure may just as likely stem from not applying the correct verification function.

In some scenarios, the lack of an inspection function poses little or no weakness in the system. For example, the lack of a *secure* function in the movement of CW munitions from stockpile to destruction facility (Scenario 2) can be compensated for by *identifying* and *quantifying* the stocks before and after movement to assure that the munitions that leave the stockpile are the same ones to arrive at the destruction facility.

In contrast, the lack of an inspection function could pose a systemic weakness in verification for which no technological means could compensate. For example, the lack of a *secure* function in the verification of schedule 2 chemical production facilities (Scenario 7) could allow undeclared production of schedule 2 chemicals between inspections to go undetected even if the identification and quantification objectives were perfectly effective at accounting for all declared activities.

1.3 MEASURES OF EFFECTIVENESS.

Applying the AA methodology to the "Measure-Of-Effectiveness" (MOE) in each verification scenario will help identify specific vulnerabilities in a system. The MOE provides a quantitative expression of the degree to which alternative verification techniques and procedures meet the stated objectives of the verification system. Adversarial analysis will use the MOE to establish:

1) an optimal technical, or baseline, effectiveness of each verification Scenario;

2) the effects on the verification systems when an adversary applies deception techniques to prevent the detection of treaty limited materials; and

3) the vulnerabilities of the verification system by showing how the effectiveness of the system is degraded by the application of deception techniques.

SECTION 2
THE JAYCOR APPROACH

The AA approach is designed to incorporate noncompliance scenarios into the evaluation of verification scenarios. The AA methodology demonstrates the relative ineffectiveness of the CRDEC verification model at detecting deliberately undeclared facilities and stockpiles.[2] The CRDEC study only examines a small section of the CWC noncompliance universe, schematically illustrated by the shaded regions in Figure 2.1.

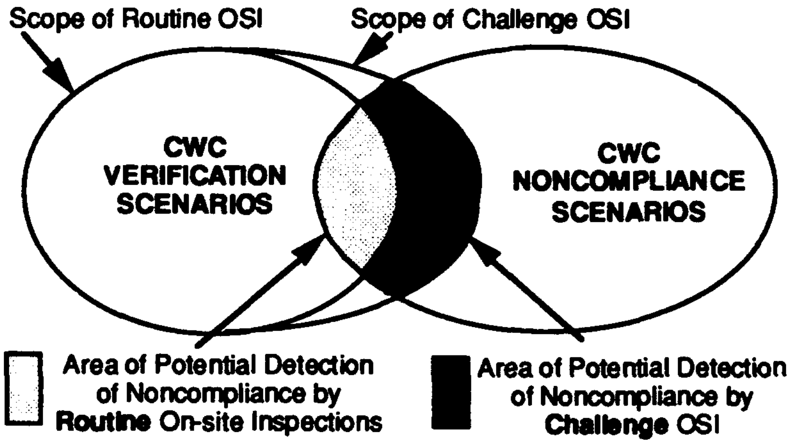

Figure 2.1. Areas of potential detection of noncompliance by routine and challenge inspections.

As the AA methodology report attests, "the verification requirements specified by the CWC are aimed at assuring the accuracy of declared CW activities, hence limiting inspection efforts to specific compliance monitoring environments. Except for fact-finding, or challenge, inspections, verification is not designed to detect noncompliance."[3] On the other hand, AA recognizes that the success of a verification regime will depend on its ability to detect noncompliance. The objectives of AA are:

1) to identify how an adversary nation might accomplish cheating, spoofing, and circumvention (CSC);

2) to reveal verification system vulnerabilities that would permit CSC; and

3) to assess the impact of such activities, qualitatively and quantitatively.

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[2] For a complete analysis of CWC noncompliance, see DNA Technical Report, "Noncompliance Scenarios: Means By Which Parties to the Chemical Weapons Convention Might Cheat," submitted by JAYCOR/NSR/Burns & Roe on October 1, 1991 (Contract No. DNA001-90-C-0173).

[3] DNA Technical Report, "Adversarial Analysis Methodology for the Chemical Weapons Convention," submitted by JACYOR/TBE/NSR on October 31, 1991 (Contract No. DNA001-91-C-0030), p. 2.

The AA team seeks to enter into the mind-set of an adversary and attempts to determine how it could defeat the verification system. AA seeks to establish the objectives of an adversary, identify all items that might indicate noncompliance, consider opportunities for deception, and assess verification system vulnerabilities. The end product of AA is a vulnerability assessment report describing the potential effectiveness of various deceptive practices and recommendations for improving the resistance of the verification regime to deception.

2.1 NONCOMPLIANT BEHAVIOR

Noncompliance with the CWC can be simple and inexpensive. The basic forms of noncompliance are shown in Table 2.1.

Table 2.1. Categories of noncompliance with the CWC.

1) development of CW;
2) production of agent, precursor, or binary components in a commercial facility;
3) production of agent, precursors, or binary components in a secret, dedicated facility;
4) diversion of chemicals from commercial production;
5) acquisition of CW;
6) providing assistance in producing CW;
7) stockpiling agent or weapons; and
8) refusing to destroy declared CW stockpiles.

In only two of these cases--production in a commercial facility and refusal to destroy declared stocks--are there practical means for verification, according to the verification regime outlined in the Rolling Text. Furthermore, verification practices focus on scheduled chemicals, whereas the production of non-scheduled (or non-classical) agents offers a tempting route to treaty circumvention. The expense involved does not need to be prohibitive. For example, a phosgene plant with a capacity of 100 tons per year is estimated to cost $2,000,000.[4] Such a facility can be constructed underground or otherwise concealed so as to be undetectable by all known sensor systems.

In the following sections, the role of the host country during inspections and concerns about the intrusiveness and protection of confidential information are examined because they are relevant to all verification scenarios. The operational concepts for each of the verification scenarios are then analyzed.

2.2 HOST COUNTRY ROLE.

Many assumptions by CRDEC regarding the host country responsibilities reflect too much of a mirror-imaging mind-set, based on the cooperative attitude of the U.S. Army toward trial inspections and a strict interpretation of the CWC Protocols. Noncompliant

[4] See "Noncompliance Scenarios", p. ii.

nations generally will be non-democratic countries or developing democracies in which the military has a strong influence on national policy. In these nations, provisions of the treaty could be partially or entirely undermined by the manipulation of the administrative requirements that the host country is assigned to perform.[5] A noncompliant nation may intentionally neglect the administrative arrangements and planning coordination. Conversely, it could employ deceptive practices in the form of rigorous implementation of all administrative procedures at a declared site to prevent the expansion of an inspection into areas containing prohibited material. During a time-constrained inspection, the detection of noncompliant activities decreases as an adversary is able to focus the inspectors' concerns on needless administrative duties. In implementing this deceptive technique, an adversary would seek to instill in the inspection team confidence of compliance with the CWC so they would less stridently search for noncompliance and any subsequent detection of noncompliant activities might be dismissed as inadvertent.

Because the host country has the right to inspect all equipment brought for inspection,[6] an adversary could gain an intelligence edge in defeating verification systems. This equipment inspection right may indicate to the host country how it can effectively mask illegal signatures so as not to be detectable by verification technologies. The required pre-inspection briefing by the host could provide another opportunity to throw the inspectors off track. The inspection team retains "the right to have photographs supplied by the host nation of relevant portions of the site;"[7] such photographs, however, could be possibly doctored.

Finally, the inspectors are required to debrief the host. An accurate description of the findings by the inspection team could serve as a valuable source of information to a noncompliant host regarding the vulnerability of undeclared, and still secret, facilities and stockpiles, and the precautions it must take in subsequent inspections. Further, the debriefing might compromise valuable intelligence sources and data gathering techniques -- especially during challenge inspections -- and jeopardize the future effectiveness of verification.

2.3 INTRUSIVENESS AND CONFIDENTIALITY.

The highly sensitive issues of inspection intrusiveness and the protection of host site confidential information are major political roadblocks to completion of the treaty. The inspectorate is limited to requesting only the information and data necessary to fulfill its responsibilities under the Convention. A potentially noncompliant state could release the strict minimum of data hoping to satisfy the curiosity of the inspectors ("denial"); otherwise, it could overwhelm the inspectorate with volumes of irrelevant information ("dazzle") while continuing to conceal its undeclared CW material.

The chemical industry has also raised concerns about the protection of proprietary rights. Private companies in the U.S. could conceivably go to court to attain an injunction

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[5] The administrative requirements are detailed in CRDEC-CR-098, Section 4, pp. 25-27.

[6] CRDEC-CR-098, Section 4.1, p. 25.

[7] CRDEC-CR-098, p. 26.

against an inspection which companies might consider to be illegal search and seizure. However, an injunction would most likely be limited to preventing challenge inspections,[8] and it is doubtful that other nations would have constitutional limitations to inspections following ratification of the treaty. Along the same lines, a noncompliant foreign government might induce its chemical industry to resist CWC inspections on the grounds of intrusiveness and threat of industrial espionage. In this manner, clandestine CW production or storage facilities embedded in commercial plants could remain undetected.

More importantly, however, the worries about protecting confidential information not related to the CWC may seriously degrade verification of the treaty. Industrial concerns in the U.S. and abroad may seek to curtail the intrusiveness allowed by the inspection teams to prevent the possibility of foreign nations and international industrial competitors gleaning valuable proprietary information during an inspection. Intrusiveness is also likely to be limited by the U.S. proposal on challenge inspections which could delay entry into a facility by up to eight days, a long step away from the "anytime, anywhere" inspections.

2.4 INSPECTION OF DECLARED STOCKPILES (SCENARIOS 1 - 2).

CRDEC maintains a technically oriented approach to confirm (or not) the accuracy of initial declarations. An estimation of the validity of the data is not examined by CRDEC but accepted at face value, thus leaving the verification system vulnerable to what a nation is willing to admit. Because intelligence estimates of the CW capabilities of foreign countries are similarly dependent on the declarations by those countries, the parameters of a verification system are formed by the declarations by state parties plus U.S. intelligence sources. This critical intelligence shortcoming is illustrated by estimates of the Soviet CW stockpile. The Soviet Union admitted to an aggregation of 50,000 agent tons in 1987;[9] however, a year later it is claimed to have acknowledged an aggregation of at least 40,000 tons of chemical munitions.[10] While the semantics of "at least" in the latter estimate and the differentiation between "agents tons" and "munitions" could be argued to form the basis of a single estimate of the Soviet stockpile, the Soviet Union could equally well use the discrepancy to conceal 10,000 tons of chemical agent or munitions.

A noncompliant nation will have full knowledge of the inspection process through the published provisions of the CWC and its Protocols. However, upon receiving notice of inspection, a noncompliant nation will have detailed information on the equipment to be used, the tests to be performed, and *ipso facto*, the signatures to be investigated, thus giving it the advantage in defeating verification sensors. Even if an undeclared CW facility were inspected, violations could be covered up by several deception techniques, including dilution, designer decontamination, and masking.

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8 For a detailed study of the constitutionality of inspections of privately-owned facilities, see David A. Koplow, "Arms Control Inspection: Constitutional Restrictions on Treaty Verification in the United States," New York University Law Review, Vol. 63, No. 2, May 1988, pp. 229-311.

9 *Soviet Military Power: Prospects for Change 1989*, Department of Defense, p. 67.

10 *Soviet Military Power: 1990*, Department of Defense, p. 15.

Furthermore, present methods for withdrawing chemical agent from munitions, such as the Ammunition Peculiar Equipment (APE), are slow and cumbersome and thus not optimized for a time-constrained, mobile verification process. Even though there are technical means under development for more rapidly determining whether a munition has a liquid fill, the analysis of a statistical sampling of a large CW stockpile may be more complex (and thus more susceptible to CSC) than CRDEC implies.[11]

Verification technologies can be subject to host party circumvention and tampering. Even if a state party is not attempting to defeat detection, prohibited or limited activities may go unnoticed by inspection teams because of legitimate safety reasons. Security systems to detect undeclared removal could be easily neutralized by host party fabrication of "safety emergencies" requiring movement of stock. In its Tooele baseline survey report, CRDEC largely discounts the effectiveness of seals on bunkers used for long-term security for similar safety reasons. The CRDEC Rocky Mountain Arsenal (EAI Report 85/91/013) report points to vulnerabilities in the application of process monitoring equipment to detect illegal production activities. In this instance, process monitors might be removed during a decontamination of pipes, eliminating any technical evidence of chemical agent(s) being run through the lines during this process, even if the decontamination is reported to the inspectors.

In its preliminary operational concepts, CRDEC acknowledges "the duty for the host nation to secure the stockpile site and assure a stockpile configuration that allows for effective use of seals and monitoring devices [during the period of the inspection]," as well as "the right of the host nation to continue necessary maintenance and safety monitoring activity at the facility."[12] These host responsibilities could provide opportunities for CSC. During the inspection, the host party has the right to accompany inspectors at all times, retain duplicate samples, witness sample analysis, inspect any verification equipment, and receive all inspection reports. The host can also provide assistance in installing monitoring equipment or analyzing samples, thus providing the violator with a pretext for CSC at critical junctures in the inspection process.

Consequently, this integral host role in the inspection process could facilitate obstructionist tactics, should the inspectors come close to undeclared facilities or stocks. Delay and diversion might be sufficient; a verification system does not have to be defeated absolutely in order for a potential adversary to achieve its objectives. CRDEC further states that the host has the obligation to "aid in the resolution of ambiguities that arise in the course of the inspection."[13] Again, this responsibility assumes a cooperative, rather than noncompliant host country.

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[11] CRDEC-CR-098, Section 5.2, p. 31.

[12] CRDEC-CR-098, Section 6.1.3, p. 47.

[13] CRDEC-CR-098, Section 6.1.3, p. 48.

2.5 DESTRUCTION AND CLOSURE PROVISIONS (SCENARIOS 3 - 5).

In its provisions defining CW destruction,[14] the CWC outlines a degree of technological sophistication that might be beyond the scope of many countries. Thus, a state party might complain about the prohibitive expense of building "environmentally safe" destruction facilities. Additionally, a nation might legitimately protest the time frame requiring an operational demilitarization facility within one year after the CWC enters into force. Soviet authorities can be expected to express misgivings over their capacity to eliminate safely the vast CW stockpile that they maintain. A potentially noncompliant state might even fabricate a CW destruction accident to gain time for diversion of stocks. The accuracy of the inspection stockpile count could be compromised by uncertainties as to how much, if any, CW was destroyed in the accident. Subsequent international verification of CW destruction could be postponed because of the threat of contamination in the site area.

The three month hiatus between CWC entry into force and cessation of all CW production could provide a grace period for rapid batch production of agents and diversion or hiding of stocks. CRDEC recognizes the difficulty in verifying compliance in an embedded production facility and notes "the duty of the facility-owning nation to disable/disconnect facility hardware to preclude additional production."[15] However, in an embedded facility, this disable/disconnect responsibility will be difficult to verify, given vulnerabilities of process monitoring equipment. Similarly, the verification regime will encounter problems when determining whether to insist on the physical destruction of a CW production facility in an embedded site. A noncompliant state might argue that such a destruction requirement would effectively disrupt the functioning of the entire chemical facility.

On the other hand, a noncompliant state might scrupulously conform to closure and destruction provisions in an obsolescent CW production facility like Rocky Mountain Arsenal. The application of stringent verification procedures to a non-producing facility might raise inspector confidence in the attitude of the country toward compliance and serve to lessen risks of discovery of continuing production at a clandestine site.

2.6 PERMITTED PRODUCTION (SCENARIOS 6 - 8).

Another area for potential CSC revolves around activities not prohibited by the Convention (Article VI of the Rolling Text.) This provision permits a single small-scale facility to produce restricted amounts of Schedule 1 chemicals (1 metric ton/year) for defensive purposes. Other smaller facilities and laboratories are also allowed to produce smaller amounts of these chemicals. Since these facilities are not subject to continuous on-site inspection or, in all likelihood, process monitoring, the possibility to violate CWC ceilings by generating intensive batch production for a brief period of time increases. To detect illegal production, CRDEC assumes that inspectors will be "tipped off" on potential violations and that verification procedures can be efficiently performed with full host cooperation. Under Article VI of the Rolling Text, inspectors will attempt to verify chemical production *ceilings*, not simply the act of production itself. Hence, inspection teams will

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[14] See CRDEC-CR-098, Section 6.3.

[15] CRDEC-CR-098, Section 6.4.3, p. 60.

examine production and capacity for production. AA can add to the inspection process by estimating the intent of the inspected party and the likelihood for production of scheduled chemicals. A key issue neglected by CRDEC is the possible production of non-classical chemicals not listed on the CWC schedules, and thus not subject to verification.

On Schedule 2 production, CRDEC admits: "Because of the mixed nature of production equipment and batch production schedules at these facilities, verification will be difficult. Confidentiality and restrictions on information gathered may be especially important under this scenario because of the highly competitive nature of the commercial chemical industry."[16] Unless human intelligence (HUMINT) sources cue inspection teams, precursor production basically will be unverifiable. On Schedule 3 (dual use production), the CWC "Rolling Text" does not even envision site inspections, but rather calls for annual declarations, to be confirmed by international audits.

2.7 CHALLENGE INSPECTIONS (CRDEC SCENARIOS 9 - 10).

Challenge inspections are characterized in the CWC Rolling Text (Article IX) as "fact-finding" missions designed to investigate suspected or alleged noncompliance by a state party. Thus, the disclosure of undeclared facilities and stockpiles will, in principle, take place by means of challenge inspections. Yet the CWC conception of challenge inspections neglects certain basic issues, including inter alia, (1) the initial detection of hidden sites and noncompliant activities; (2) compensation for national security reservations of the challenged party; (3) limitation of inspection intrusiveness so as not to infringe on proprietary rights of commercial facilities; and (4) implementing inspections when dealing with a hostile host country. The experience of the UN inspection teams in Iraq will be valuable for understanding the requirements of the latter issue.

Since the mechanics of challenge inspections remain a major point of contention in the CWC negotiations, it is extremely difficult to speculate about the final relevant provisions of the treaty. In its July 1991 proposal to the Geneva negotiations, the United States expressed concern about CWC challenge inspections compromising highly sensitive national security facilities unrelated to CW production and storage. The U.S. plan would permit the challenged party to establish a site perimeter and to shroud sensitive equipment. This proposal raised criticisms that a noncompliant nation could technically use the same arguments about supposedly vital national security interests to stymie a challenge inspection.

Fact-finding missions would be heavily dependent upon HUMINT sources for revelation of CWC violations. To overcome the reliance on serendipitous information, it may be necessary to include an inspection function to investigate. The "investigate" function may use existing functions, but tailor them to the unique environments of the challenge inspections. Tailored objectives would include establishing the purpose of suspect facilities, quantifying potential production capacities, if possible, and potentially searching for clandestine sites (as is currently being done by the UN missions in Iraq).

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[16] CRDEC-CR-098, Section 6.7.2, p. 69.

CRDEC acknowledges the uncertainties and hazards attached to any challenge inspection effort. In the investigation of alleged use (Scenario 9), "even if the use of chemical agents is verified, the identification of the user becomes a paramount problem."[17] Chemical analysis could be defeated by very low trace levels, especially since the decomposition products for some chemical agents, especially non-persistent agents, are similar to those that occur naturally in human or animal corpses. The existence of unknown chemicals could further complicate the effectiveness of chemical analysis. In contrast, in the investigation of facilities (Scenario 10), chemical analysis is highly sensitive to even trace levels of Scheduled chemical agents. However, the sensitivity of the machines also makes them vulnerable to various deception techniques, including alleged accidents or the manipulation of initial equipment calibrations. Implicit in the CRDEC discussion of the two challenge inspection scenarios is the recognition that the host party may well be uncooperative, if not overtly hostile. The UN experience in Iraq provides a case study where the inspected state consistently sought to impede or curtail inspection procedures, even at the risk of provoking an armed response from the United States and its allies. Iraq initially declared less than one-quarter of its chemical stockpile that the UN team later discovered.

[17] CRDEC-CR-098, Section 6.9.2, p. 74.

SECTION 3
CONCLUSION

Based on the analysis above, it is apparent that the CRDEC preliminary operational concepts methodology examines only a portion of the potential CWC noncompliance activities. To broaden the scope of the verification scenarios, AA provides a supplementary methodology to reduce the impact of noncompliance. The disparity between the goals of an adversary and the verification system could pose a systemic weakness in verification for which no technological means can compensate. Deception and denial activities by noncompliant host parties should be factored into any credible verification regime, to be offset by effective verification technologies and objectives. Greater attention has to be paid to noncompliance scenarios reflecting a plausible blueprint of what an adversary will do to cheat, and what it must conceal to avoid detection by the verification regime. CRDEC has presented a comprehensive methodology designed to verify facilities and stocks of state parties prepared to comply with the CWC.

The JAYCOR team recommends augmenting the CRDEC operational concepts with a step-by-step strategy to identify those nations that intentionally fail to comply with the provisions of the treaty and to impose a higher cost for noncompliance on those nations by requiring more elaborate, and hence more expensive, deception techniques. This aspect is of critical importance because, by most yardsticks, the CWC will be an extremely difficult international agreement to verify satisfactorily.

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